Evaluation of the acceptability and usability of Augmentative and Alternative Communication (ACC) tools: the example of Pictogram grid communication systems with voice output.

LUCIE CHASSEUR, MARION DOHEN, BENJAMIN LECOUTEUX, SÉBASTIEN RIOU, AMÉLIE ROCHET-CAPELLAN, and DIDIER SCHWAB, Laboratoire d'Informatique de Grenoble, Grenoble, France and Université Grenoble Alpes, CNRS, Grenoble INP, Gipsa-lab, Grenoble, France

The multiplication of communication software based on pictogram grids with voice output has led to the democratisation of this type of tool. To date, however, there is no standard, nor systematic evaluation that makes it possible to objectively measure the suitability of these tools for a given language. There are also no methods for designers to improve the organisation of words into grids to optimise sentence production. This paper is a first step in this direction. We represented the Proloquo2Go® Crescendo vocabulary for a given grid size as a graph and computed the production cost of frequent sentences in French. This cost depends on the physical distance between the pictograms on a given page and navigation between pages. We discuss the interest of this approach for the evaluation as well as the conception of communicative pictogram grids.

Additional Key Words and Phrases: Augmentative and Alternative Communication, pictogram grid communication systems, evaluation

ACM Reference Format:

Lucie Chasseur, Marion Dohen, Benjamin Lecouteux, Sébastien Riou, Amélie Rochet-Capellan, and Didier Schwab. 2020. Evaluation of the acceptability and usability of Augmentative and Alternative Communication (ACC) tools: the example of Pictogram grid communication systems with voice output.. 1, 1 (October 2020), 5 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 INTRODUCTION

Augmentative and Alternative Communication (AAC) is defined by the National Joint Committee of the American Speech-Language-Hearing Association as: *"multiple ways to communicate that can supplement or compensate (either temporarily or permanently) for the impairment and disability patterns of individuals with severe expressive communication disorders"*. Pictogram grid communication systems (PGCS) with voice output provide an interesting support for the communication of speakers with speech and language impairment. First available only on dedicated devices, they are now available on computers, tablet computers as well as smartphones for free or at a reasonable cost. In most of the cases, the software include a "vocabulary" i.e. a set of words associated with pictograms for a given language. Pictograms are then organised into pages of two-dimensional tables. This organisation depends on the designers' view of language organisation and can favour

Authors' address: Lucie Chasseur; Marion Dohen; Benjamin Lecouteux; Sébastien Riou; Amélie Rochet-Capellan; Didier Schwab, Laboratoire d'Informatique de Grenoble, Grenoble, France, Université Grenoble Alpes, CNRS, Grenoble INP, Gipsa-lab, Grenoble, France.

XXXX-XXXX/2020/10-ART $15.00

https://doi.org/10.1145/nnnnnnn.nnnnnnn

lexical, pragmatic or syntactic constraints. The software then provides various functionalities of use or adaptation of the vocabulary. In use, speakers build their messages by sequentially pointing to the pictograms, which is significantly much slower than natural speaking. Moreover, most of the vocabularies and organisations were conceived for a given language and later on translated into another, which questions the optimisation of the vocabulary. Beside, families and healthcare professionals can have a hard time finding the best suitable tools, due to the growing quantity of new apps and the lack of scientific comparison between their usability and efficiency. A first step to evaluate the efficiency of these tools is to estimate the time cost of building common sentences in the target language. At a physical level, this time will still strongly depend on the pointing duration from one picture to the other and navigation time between pages. Our aim is to provide an automatic evaluation of this timing regardless of other higher-level parameters involved in sentence production which still strongly impact the production duration. We propose a tool to estimate a cost of production for common French sentences with PGCS. This tool was empirically evaluated for the Crescendo vocabulary of Proloquo2Go®. This article will begin with an explanation of the method we have developed to evaluate the cost of producing sentences with a PGCS, then we will present an example of application, and we will finish by putting our tool into perspective.

2 MOTOR PRODUCTION COST AND METHODOLOGY

In order to have a first glimpse of what the evaluation of an AAC tool can be, we chose to mathematically materialise the motor production cost for a sentence. We define the motor production cost by the minimal number of actions needed to compose a message with a PGCS. To be able to automatically compute it whatever the message (phrase, sentence, text, . . .), we need a mathematical representation, the straightforward one is a directed weighted graph.

2.1 PGCS representation and interaction

PGCS are represented as a group of various grids. In each of these grids one can find pictograms expressing ideas, concepts, words or phrases which we can be used to form sentences or texts. In addition to these pictograms, some buttons, defining categories or actions, are used to navigate between the grids. For the representation of these grid-to-grid links, and for the rest of the PGCS architecture, we designed an open format (the *interaaction group open format*) allowing us to precisely describe each of the grids of the PGCS, and each of the items composing the grids. This format is used in an open PGCS software developed in the team, outside of the scope of this article[1]. Interactions with PGCS are heterogeneous, they can occur through touch, gaze tracking, buttons, etc. All interactions don't have the same cost for selection or displacements. For instance, a touch interaction can be short or long (click, long press...) while a Gaze tracking interaction, which often uses dwell interaction[5] [7] so that a pictogram is selected only when gaze stays on it during a certain time, will have a really low displacement cost but a quite long selection one, based on dwell time. These costs depend on user abilities. For instance if the user has strong cognitive difficulties (apraxia for instance) the cost will be bigger than a cost produced by a user without cognitive difficulties. We note n as the cost of the interaction for selection, m the cost of interaction for displacement.

2.2 Graph representation

Mathematically, a directed weighted graph is a pair G = (N,E) where N is a set of elements called nodes, and E is a set of one-way weighted edges (or arcs) linking the nodes together. Here we use

[1] AugCom github website https://github.com/InteraactionGroup/AugCom

them in order to represent the cost of going from one pictogram to another or the cost of navigating between pages in a PGCS.

2.2.1 Nodes. To form the nodes, we manually created a list of the tool's pictograms. We assigned a unique identifier to all the pages and all the pictograms. It is composed of three parts: The word associated to the pictogram, a separator: "@" and the unique identifier of the page containing the pictogram. So, if we want to give an identifier to the "I" pictogram on the "home" page to create a node we use: **"I@home"**. However, at least two types of pictograms can be differentiated in the same page; "word pictograms" and "directory pictograms". A pictogram such as "I", in the previous example, belongs to the "word pictograms" category since its only action is to convey a meaning. On the contrary, pictograms such as the "places" pictogram do not serve to communicate a meaning directly but to redirect to a new page linked to places. The directory pictograms are differentiated from the word pictograms by adding a "_R" at the end of the words. This method of identification allows us to clearly differentiate between pictograms that are identical but are not stored in the same place in the application.

2.2.2 Edges and weight. Besides, we created the edges of the graph. Four different types of edges can be distinguished. The edges representing the cost to go from one pictogram P_1 to another pictogram P_2 on the same page (1). In this case the corresponding cost is $C = D(P_1, P_2)m + n$ where $D(P_1, P_2)$ is the distance between the pictograms; m is the cost of interaction for displacement telling us in how many seconds we can cross one pictogram; n is the time cost for the select interaction in seconds. We can distinguish two different steps to move from one page to another. There is the step of selecting the directory, which is similar to a simple move from pictogram to pictogram but without the selection (2). Thus, for this part, the cost is $C = D(P_1, P_2)m$. After that we had to estimate the cost of moving from a directory pictogram to a page (3), we estimate that this one corresponds to the cost of the selection. On all PGCS we study, only one action (selection) is needed, in this case, the corresponding cost is $n = (1 \times n)$. And finally we calculate the weight of the arcs corresponding to the passage from the page to the pictogram (4). The calculation of this weight is not much different from the calculation made for "pictogram to pictogram" edges. For now, we choose to compute the distance "page to pictogram" as the distance between the top left pictogram of the page and the selected pictogram. This is a first hypothesis which could be easily modified in the future following new approaches (middle of the page, location in the previous page,...). In this first study, our hypothesis is that people start to search for pictograms from the upper left part of grid. In addition, Proloquo2Go® is a tool designed so that the user always starts from the top left because it is based on the reading direction. So, $D(P_{(1,1)}, P_2)m + n$ where $D(P_{(1,1)}, P_2)$ is the distance between the pictogram with the coordinates line 1 and column 1 and the pictogram selected.

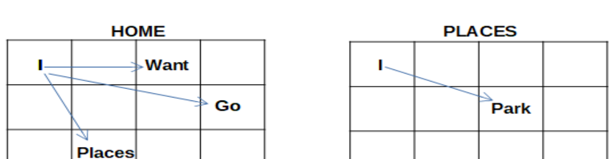

Fig. 1. Diagram of the arcs and their distances

For instance, on the *figure* 1, the cost to move from I to *Want* is $2m + n$, while it is $3,16m + n$ between I and *Go* ($\sqrt{(3^2 + 1^2)}m + n$) and $2.24m + n$ between I and places ($\sqrt{(1^2 + 2^2)}m + n$).

2.3 Extraction of the shortest path

In this part, the system takes a written text read line by line. For each line, it scans the path and establishes a list of potential "candidate paths" per word pair. For example, if we take the sentence *I want to play*, the system will list all the possible arcs to go from the word *I* on any page to the word *Want* on the same page or on any other page and so on with all the words of the sentence. We will then have a list of arcs of the type (I@pageA,want@pageB) with a given weight. These arcs are stored in memory to create a new graph and a Dikjstra algorithm can then be applied to find the shortest path.

2.4 Corpus

A corpus is a collection of documents used for a specific research purpose. We choose to use the corpus *ESLO 2* (Sociolinguistic Survey in Orleans). This one includes about 400 hours of oral speech in different social situation. These transcribed speech hours will therefore be used as reference sentences to compare the different production cost between the PGCS. Using this corpus allows us to have a wide choice in our sentence selections. Indeed, we are not reduced to conversations between adults we can also select sentences from parents to children. The use of this child's speech is a definite advantage for testing the PGCS that are directly addressed to them.

3 APPLICATIONS

To illustrate our method we use here the sentence : *I want to go to the park* or more precisely *I want go park* which is not grammatically correct but closer of what is often done with PGCS. Indeed, user often wants to create a sentence quickly which does not necessarily make grammatically correct sentences. For this example, we have used the coordinates of the pictograms in *figure* 1 and the shortest path given by the system for this sentence is the following one: **['home', 'I@home', 'want@home', 'go@home', 'places_R@home', 'places', 'park@places']**.

Following the method the cost for a user with no particular problem and using touch ($m = 0,5$, $n = 0,2$) is $4,42s$. For the same user, but using eye-tracking with dwell selection, the cost will be bigger, we can take $m = 0,2$ (faster displacement) and $n = 1$ (longer selection) for exemple, which gives $5,16s$ while for a user with dispraxia the coefficients values will increase ($m = 2$ $n = 5$ for instance), giving a total production cost equal to $27,4s$. All code is open source and permits to compute this cost for any PGCS in the Interaaction Group Open format and is available on GitHub[2]. We intend to continue to develop this project and to introduce new metrics and corpus.

4 CONCLUSION & PERSPECTIVES

The lack of standards and methods to evaluate the layout of PGCS makes the design of AAC tools hard to improve and hard to correctly suit to the targeted population. Our system offers a possible opening on the evaluation of PGCS. Indeed, it is able to calculate the cost of a message from a correctly described tool and it also makes possible to find the shortest path to reach a pictogram. Of course, it is based on a perfect knowledge of the tool, while it is clear that users may not have this knowledge and/or may need a long training. However, the cost of moving from one pictogram to another, selecting the pictogram, navigating between pages is an irreducible cost that should be optimised considering common sentences of the target language. We hope that our evaluation system will initially allow us to optimise sentence production and the usability of the tools in context. In addition, we want parents, speech and language therapists and users to have a real means of comparing the effectiveness of the tools whatever the reason for their use.

[2] https://github.com/InteraactionGroup/Pictogram-Grid-Communication-Systems-Evaluator

REFERENCES

[1] David R. BEUKELMAN and Pat MIRENDA. [n.d.]. *Communication alternative et améliorée Aider les enfants et les adultes avec des difficultés de communication.*

[2] Elisabeth CATAIX-NEGRE. [n.d.]. *Communiquer autrement, Accompagner les personnes avec des troubles de la parole ou du langage.*

[3] Dominique CRUNELLE. [n.d.]. *Évaluer et faciliter la communication des personnes en situation de handicap complexe Polyhandicap, autisme, AVC, traumatisme crânien, démence, syndrome d'Angelman, syndrome de Rett, autres anomalies génétiques, autisme déficitaire, AVC sévère, traumatisme crânien, démences, ...*

[4] I. ESHKOL-TARAVELLA, L. KANAAN-CAILLOL, O. BAUDE, C. DUGUA, and D. MAUREL. [n.d.]. Procédure d'anonymisation et traitement automatique : l'expérience d'ESLO. ([n. d.]).

[5] J. K. Jacob, Robert. [n.d.]. The use of eye movements in human-computer interaction techniques: what you look at is what you get. ([n. d.]). https://doi.org/10.1145/123078.128728

[6] Abouda L. and Skrovec M. [n.d.]. Pour une micro-diachronie de l'oral : le corpus ESLO-MD. 46 ([n. d.]). https://doi.org/10.1051/shsconf/20184611004

[7] P. Majarante and C. Stephanidis. [n.d.]. *The Universal Access Handbook.* 1–20 pages.

[8] A. Moorcroft, N. Scarinci, and C. Meyer. [n.d.]. "I've had a love-hate, I mean mostly hate relationship with these PODD books": parent perceptions of how they and their child contributed to AAC rejection and abandonment. ([n. d.]), 1–11. https://doi.org/10.1080/17483107.2019.1632944

[9] MaryAnn Romski and Rose A. Sevcik. [n.d.]. Augmentative Communication and Early Intervention: Myths and Realities. 18, 3 ([n. d.]), 174–185. https://doi.org/10.1097/00001163-200507000-00002